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Abstract

Background

Hypertension is estimated to cause more than one-eighth of all deaths worldwide. In Canada, the last national surveys to include direct measures of blood pressure (BP) took place over the years 1985-1992, hypertension was estimated at 21%.

Data and methods

Data are from cycle 1 of the Canadian Health Measures Survey, conducted from March 2007 through February 2009. The survey included direct BP measures using an automated device. Weighted frequencies, means and cross-tabulations were produced to estimate levels of hypertension awareness, treatment and control in the population aged 20 to 79 years.

Results

Among adults aged 20 to 79 years, hypertension (systolic BP higher than or equal to 140 or diastolic BP higher than or equal to 90 mm Hg, or self-reported recent medication use for high BP) was present in 19%. Another 20% had BP in the pre-hypertension range (systolic 120 to 139 or diastolic 80 to 89 mm Hg). Of those with hypertension, 83% were aware, 80% were taking antihypertensive drugs, and 66% were controlled. Uncontrolled hypertension was largely due to high systolic BP.

Interpretation

Hypertension prevalence is similar to that reported in 1992. Since then, the level of hypertension control has increased considerably.

Keywords

awareness, blood pressure determination, hypertension, population surveillance

Authors

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Hypertension is an important risk factor for cardiac, cerebrovascular and other vascular diseases.[1-5] Hypertension is also a major cause of disability and is considered to be the leading risk factor for death in the world, causing an estimated 7.5 million deaths per year (13% of all deaths).[6] Surveillance of BP in the population provides vital feedback to hypertension prevention and control efforts. With the recent Canadian Health Measures Survey (CHMS), direct, automated measures of BP were collected from a representative sample of people, allowing for the most accurate nationwide assessment of the prevalence of hypertension that has ever been undertaken.

BP control is crucial in reducing the risk of cardiovascular disease among people with hypertension. In the past 15 years, management of hypertension has improved in many Western countries, but remains less than optimal,[7] even though anti-hypertensive drugs, modifications to diet, weight and physical activity levels, and limitation of alcohol consumption can be quite effective in its control and treatment.

National data based on direct BP measures had last been collected by the Canadian Heart Health Surveys (CHHS), conducted in the provinces over the 1985 to 1992 period.[8,9] At that time, although the prevalence of hypertension was similar in Canada and the United States, levels of awareness, treatment and control were higher in the United States.[10]

Since the late 1990s, extensive efforts have been underway in Canada to improve physician and public awareness of the importance of treatment and control of hypertension.[11] Initiatives such as the Canadian Hypertension Education Program (http://www.hypertension.ca/chep), and campaigns by organizations including Blood Pressure Canada (http://

www.hypertension.ca/bpc) and the Heart and Stroke Foundation of Canada (http:www.heartandstroke.com/site) exemplify such endeavours. Perhaps not coincidentally, findings from a recent population survey in Ontario suggest that control of hypertension among those with the condition increased more than fivefold between 1992 and 2006—from 12% to 66%.[12] However, this improvement requires corroboration and assessment to determine if the Ontario results apply to Canada as a whole.

Surveillance of hypertension presents unique challenges. Unlike most other chronic conditions, hypertension is predominantly "silent," or asymptomatic. Therefore, when assessment of hypertension is limited to data from questionnaire-based health surveys, its prevalence is usually underestimated.[13] Direct BP measurement, because it is not contingent upon diagnosis or awareness, may provide more accurate estimates of the prevalence of hypertension. Furthermore, from the values obtained by direct measurement, the distribution of BP in the population can be portrayed, and comparisons can be made among subpopulations. Finally, combining data based on direct measures with self-reported information on diagnosis and treatment yields important information about hypertension awareness, treatment and control.

Cycle 1 of the CHMS was launched in 2007 by Statistics Canada, in partnership with Health Canada and the Public Health Agency of Canada.[14] As well as a detailed health-related questionnaire, the survey includes the most comprehensive set of physical measures ever collected in Canada from a population-based sample, among which is direct measurement of BP.

The objectives of this preliminary study are to describe the distribution of BP in the Canadian adult population, and to provide estimates of the prevalence of hypertension by sex and age group. Levels of hypertension awareness, treatment and control are also reported.

Methods

Data source

Data for this study are from cycle 1 of the CHMS, which collected data at 15 sites across Canada from March 2007 through February 2009.[14] The survey covered the population aged 6 to 79 years living in private households. It was designed to provide sex-specific, statistically reliable national estimates of conditions for which prevalence was at least 10% for five age-groups: 6 to 11, 12 to 19, 20 to 39, 40 to 59, and 60 to 79 years.[15] This analysis is limited to respondents aged 20 to 79 years; a subsequent study will focus on BP in the age group 6 to 19 years.[16] The CHMS does not include residents of Indian Reserves or Crown lands, institutions and certain remote regions, and full-time members of the regular Canadian Forces.

Of the households selected for inclusion in the CHMS, the response rate was 69.6%—meaning that in 69.6% of the selected households, the sex and date of birth of all household members were provided by a household resident. In each responding household, one or two members were selected to participate in the survey; for the age group 20 to 79 years, 87.9% of selected household members completed the household questionnaire, and 83.6% of the responding household members participated in the subsequent examination component of the survey. The final response rate was not calculated as simply the product of these response fractions, because of the complexities involved in selecting two respondents in certain households.[16,17] The final response rate, after adjusting for the sampling strategy, was 50.9%.

Ethics approval for the CHMS was obtained from Health Canada's Research Ethics Board. Written consent was requested from respondents before participation. Respondents were informed that participation was voluntary, and that they could opt out of any part of the survey at any time. Additional information about the survey is available in previously published reports[15,17-20] and on Statistics Canada's website (http://www.statcan.gc.ca).

Measures

During a personal in-home interview, a trained interviewer administered a questionnaire covering socio-demographic characteristics, medical history, current health status and lifestyle behaviours. In the chronic conditions component of the interview, respondents were asked two yes/no questions about BP: whether they had high BP (diagnosed by a health professional and expected to last or having already lasted six months or more); and whether they had taken "medicine for high blood pressure" in the past month.

On an appointed date after the interview, physical measurements, including BP, heart rate, height, weight, and physical fitness, as well as blood and urine samples, were obtained at a mobile examination centre. To maximize response rates, respondents who were unwilling or unable to go to the centre were offered the option of a home visit. The BP protocol used to conduct measurements in the home did not differ from that used in the mobile centre.

BP and heart rate were measured with the BpTRU™ BP-300 device (BpTRU Medical Devices Ltd., Coquitlam, British Columbia) at the mobile examination centre, and with the BpTRU™ BP-100 device during home visits. The BpTRU™ is an automated electronic monitor using an upper arm cuff. The device, which automatically inflates and deflates the cuff, and uses the oscillometric technique to calculate systolic BP (SBP) and diastolic BP (DBP), has passed international validation protocols for accuracy.[21,22]

An important advantage of an automated device is that it enables BP to be measured in the absence of another person. Its use, therefore, eliminates observer errors such as digit bias, zero preference and incorrect deflation rates, and also reduces "white coat hypertension"[23]—a rise in BP associated with the presence of the health care professional and the procedures of measurement. (For more information on the procedures and protocol used, see *Resting blood pressure and heart rate*

measurement in the Canadian Health Measures Survey by Bryan et al.[24]).

Definitions

Measures of SBP and DBP were calculated by taking the average of the first set (last five of six measures taken one minute apart) of valid BP measurements.[24] The classification scheme used to categorize measured BP was that defined in the seventh report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC 7)[25]:

JNC 7 category	Blood pressure (mm Hg)
Normal	Systolic lower than 120 and diastolic lower than 80
Prehypertension	Systolic 120 to 139 or diastolic 80 to 89
Hypertension	Systolic 140 or higher, or diastolic 90 or higher
Stage 1	Systolic 140 to 159 or diastolic 90 to 99
Stage 2	Systolic 160 or higher, or diastolic 100 or higher

For individuals whose SBP and DBP fell into different categories, the higher category was used for classification.

Normal blood pressure was defined as a measured mean SBP lower than 120 mm Hg and a measured mean DBP lower than 80 mm Hg.

Prehypertension was defined as a measured mean SBP of 120 to 139 or DBP of 80 to 89 mm Hg.

Hypertension was defined as a measured mean SBP of 140 mm Hg or higher, or a measured mean DBP of 90 mm Hg or higher, or the respondent's report of BP medication use in the past month.

Treated hypertension was defined as a respondent's report of BP medication use in the past month.

Awareness of hypertension was defined as a respondent's report of either diagnosed hypertension or BP medication use in the past month.

Controlled hypertension was defined as the respondent's report of BP medication use in the past month together with measured mean BP values lower than 140 mm Hg (systolic) and 90 mm Hg (diastolic).

Isolated systolic hypertension was defined as measured SBP of 140 mm Hg or higher, together with measured DBP lower than 90 mm Hg.

Isolated diastolic hypertension was defined as measured DBP of 90 mm Hg or higher, together with measured SBP lower than 140 mm Hg.

Analytical techniques

Based on weighted data from cycle 1 of the CHMS, frequencies, means and cross-tabulations were produced to estimate the distribution of BP, the prevalence of normal BP and hypertension, and awareness, treatment and control of hypertension in the household population aged 20 through 79 years. To account for the complex design of the survey, variance on estimates and significance testing on differences between estimates were calculated with the bootstrap technique.[26,27] Significance was specified as a p-value of less than 0.05.

Results

For cycle 1 of the CHMS, BP measures were obtained for 3,514 respondents aged 20 through 79 years: 3,493 at the mobile examination centre and 21 in their homes. The data were weighted to be representative of 23.7 million Canadian adults in this age range.

Average values of SBP and DBP differed by age and sex. In the age groups 20 to 39 and 40 to 59 years, the mean SBP values for females (101.4 and 111.7 mm Hg, respectively) were lower than those for males (109.9 and 116.5 mm Hg) (Table 1). However, in the age group 60 to 79 years, the mean SBP value was higher for females (126.9 mm Hg) than for males (122.4 mm Hg). For DBP, mean values were consistently lower in females than in males. The average values of SBP rose with age in each sex, while average DBP peaked in middle age and then declined slightly (Figure 1).

Based on measured BP and self-reported BP medication use, hypertension was present in an estimated 19% (4.6 million) of Canadian adults aged 20 to 79 years (Table 2, Figure 2). The overall prevalence of hypertension was nearly the same in males (19.7%) and females (19.0%).

The prevalence of hypertension rose with age in both sexes combined. At ages 20 to 39 years, approximately 2% had hypertension, compared with 18% of those aged 40 to 59 years, and 53% of those aged 60 to 79 years.

Three-fifths (61%) of adults had BP in the normal range, and 20% were classified as prehypertensive (Table 2). The likelihood of prehypertension was higher in males (25%) than in females (15%). At ages 60 to 79 years, the percentage with normal BP (23%) was about equal to the percentage classified as prehypertensive (24%).

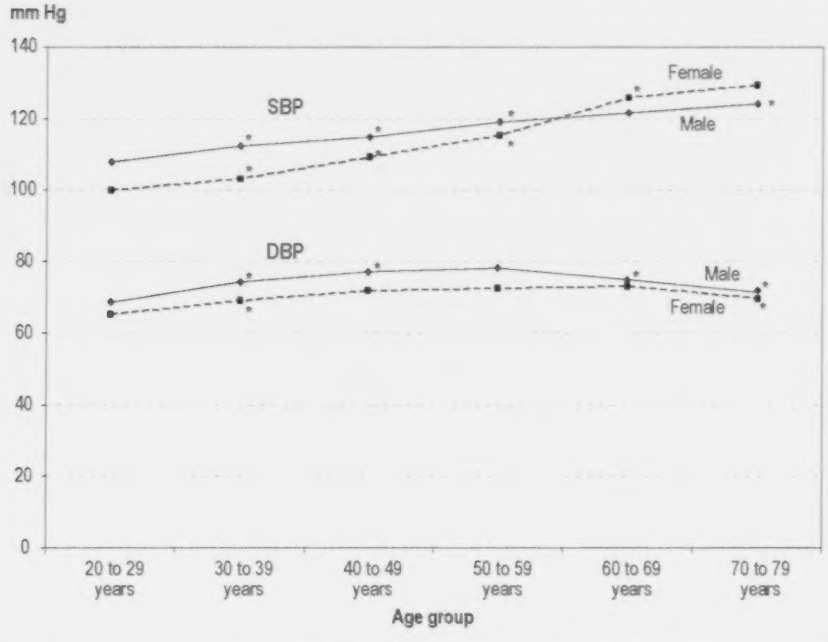
More than four-fifths (83%) of people with hypertension were aware

Table 1
Mean measured value of systolic (SBP) and diastolic blood pressure (DBP) (mm Hg), by sex and age group, household population aged 20 to 79 years, Canada, March 2007 to February 2009

Type of blood pressure and sex	Total	20 to 39 years	40 to 59 years	60 to 79 years
SBP				
Male†	115.1	109.9	116.5	122.4
Female	111.1*	101.4*	111.7*	126.9*
DBP				
Male†	74.5	71.5	77.5	73.8
Female	70.1*	67.1*	71.9*	71.7*

† reference category
* significantly different from estimate for reference category ($p<0.05$)
Note: For SBP, comparisons of sex-specific estimates by age group are all significantly different from each other ($p<0.05$) except for differences between age groups 40 to 59 and 60 to 79 in females.
Source: 2007-2009 Canadian Health Measures Survey.

Figure 1
Mean systolic (SBP) and diastolic blood pressure (DBP) (mm Hg), by sex and age group, household population aged 20 to 79 years, Canada, March 2007 to February 2009



* significantly different from sex-specific estimates for previous age group ($p<0.05$)
Note: All age-group-specific comparisons between males and females are significantly different ($p<0.05$) except for DBP in 70-to-79-year age group.
Source: 2007-2009 Canadian Health Measures Survey.

of their condition, and 80% were being treated with antihypertensive drugs (Table 3, Figure 3). Two-thirds (66%) of those with hypertension had BP that was controlled (lower than 140 mm Hg systolic and lower than 90 mm Hg diastolic) by medication. Finally, 17% of adults with hypertension were unaware of their condition, a situation more common in males (20%) than in females (14%).

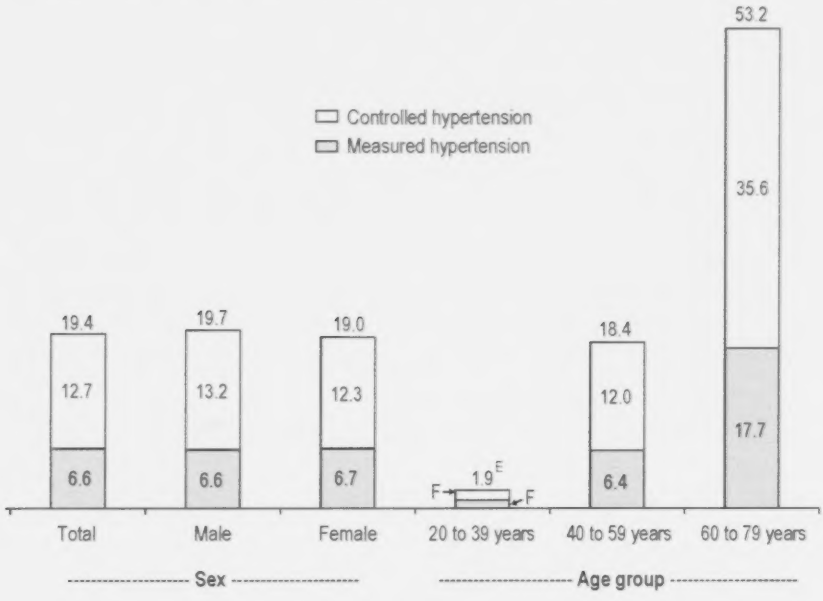
The percentages of hypertension control were similar in males (67%) and females (65%), despite the lower likelihood that males with hypertension were using antihypertensive medication (76% for males and 83% for females). Among females taking antihypertensive medication, the percentage whose BP was not controlled was higher than the corresponding figure for males (18% and 10%, respectively). Supplementary analysis revealed that the gap in BP control between the sexes was present only at older ages; in females aged 60 to 69 years who were using antihypertensive medication, the percentage not controlled was 19%, compared with 7% in males; the corresponding estimates in the age group 70 to 79 years were 37% versus 18% (data not shown).

Table 2
Percentage distribution of measured blood pressure, by hypertension status and JNC7[26] blood pressure category, by sex and age group, household population aged 20 to 79 years , Canada, March 2007 to February 2009

	Non-hypertensive				Hypertensive					
							Controlled		Uncontrolled	
Sex and age group	Sample size	Total	SBP lower than 120 and DBP lower than 80 mm Hg	SBP 120 to 139 or DBP 80 to 89 mm Hg	Sample size	Total	SBP lower than 120 and DBP lower than 80 mm Hg	SBP 120 to 139 or DBP 80 to 89 mm Hg	SBP 140 to 159 or DBP 90 to 99 mm Hg	SBP higher than or equal to 160 or DBP higher than or equal to 100 mm Hg
Total	**2,650**	**80.6**	**60.5**	**20.1**	**864**	**19.4**	**5.9**	**6.9**	**5.3**	**1.3**[E]
Sex										
Male[†]	1,208	80.3	55.0	25.3	441	19.7	5.6	7.6	5.9	0.7[E]
Female	1,442	81.0	65.9*	15.1*	423	19.0	6.1	6.2	4.8	1.9[E]
Age group										
20 to 39 years	1,152	98.1*	83.6*	14.5*	33	1.9[E]*	F	F	F	F
40 to 59 years[†]	996	81.6	58.1	23.4	238	18.4	5.3	6.8[E]	5.3	1.1[E]
60 to 79 years	502	46.6*	22.9*	23.8	593	53.2*	16.5*	19.1*	13.8*	3.9[E]

† reference category
‡ measured SBP 140 mm Hg or measured DBP higher than or equal to 90 mm Hg or self-reported use of antihypertensive medication in month before Canadian Health Measures Survey interview
* significantly different from estimate for reference category ($p<0.05$)
E interpret with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be reported (coefficient of variation greater than 33.3%)
Source: 2007-2009 Canadian Health Measures Survey.

Figure 2
Percentage with hypertension,[1] by sex and age group, household population aged 20 to 79 years, Canada, March 2007 to February 2009



[1] measured SBP higher than or equal to 140 or DBP higher than or equal to 90 mm Hg, or current use of antihypertensive medication
[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be reported (coefficient of variation greater than 33.3%)
Note: Because of rounding, detail may not sum to total.
Source: 2007-2009 Canadian Health Measures Survey.

Table 3
Percentage with hypertension[1] who are aware, treated by medication, controlled, by sex and age group, household population aged 20 to 79 years with hypertension, Canada, March 2007 to February 2009

Sex and age group	Total aware	Total treated	Treated, controlled[2]	Treated, not controlled[3]	Aware, not treated	Unaware	Total not controlled
Total	**83.4**	**79.9**	**65.9**	**14.0**	**3.5**[E]	**16.6**	**34.1**
Sex							
Male[††]	80.4	76.5	66.8	9.7[E]	3.9[E]	19.7	33.2
Female	86.5*	83.3*	64.9	18.4[E]*	F	13.5*	35.1
Age group							
20 to 39 years	64.4	58.4[E]	56.8[E]	F	F	35.6[E]	43.2[E]
40 to 59 years[††]	80.4	73.4	65.4	8.0[E]	7.0[E]	19.6	34.6
60 to 79 years	86.7*	85.7*	66.8	19.0*	F	13.3*	33.2

[1] measured SBP higher than or equal to 140 mm Hg or measured DBP higher than or equal to 90 mm Hg or self-reported use of antihypertensive medication in month before CHMS interview
[2] measured SBP lower than 140 mm Hg and measured DBP lower than 90 mm Hg
[3] measured SBP higher than or equal to 140 mm Hg or measured DBP higher than or equal to 90 mm Hg
[††] reference category
* significantly different from estimate for reference category ($p<0.05$)
[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be reported (coefficient of variation greater than 33.3%)
Note: Because of rounding, detail may not sum to total.
Source: 2007-2009 Canadian Health Measures Survey.

For both sexes combined, the likelihood of hypertension control by medication was nearly the same in the age groups 60 to 79 years (67%) and 40 to 59 years (65%). Although the point estimate of control (57%) was substantially lower in those aged 20 to 39 years, the differences compared with the other age groups were not statistically significant because of the low sample size of the younger age group.

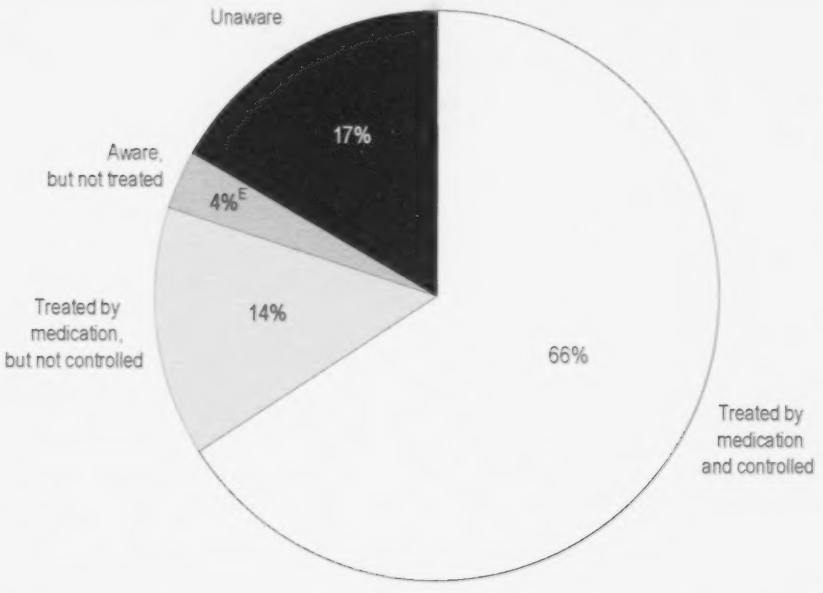
High SBP, with a prevalence of 5.4% in the adult population, was twice as common as high DBP (2.7%) (Table 4). The difference between the percentages of females (6.0%) and males (4.8%) measured as having high SBP was not statistically significant. High DBP affected a significantly lower percentage of females (2.0%) than males (3.4%). In contrast, a higher percentage of females (4.7%) than males (3.2%) were categorized as having isolated high SBP. The prevalence of high SBP and isolated high SBP increased sharply with age.

Among adults reporting current use of antihypertensive medication, 42% had measured SBP lower than 120 mm Hg; in 25%, SBP was at least 120 mm Hg but lower than 130 mm Hg, and in 17%, it was in the 130 to 139 mm Hg range (Figure 4). About one in six (16%) of those being treated with medication had a measured SBP value of 140 mm Hg or higher. DBP was lower than 80 mm Hg in 70% of adults using antihypertensive medication (Figure 5). Supplementary analysis focusing on treated but uncontrolled hypertensives revealed that nine in ten had systolic hypertension, compared with about one-quarter who had diastolic hypertension (data not shown). In summary, uncontrolled hypertension in people treated with antihypertensive medication was largely due to elevated SBP.

Discussion

The Canadian Health Measures Survey (CHMS) indicates that nearly one-fifth (19%) of adults aged 20 to 79 years have hypertension. This estimate is slightly lower than that reported from the

Figure 3
Percentage with hypertension[†] who are aware, treated by medication, controlled,[‡] household population aged 20 to 79 years with hypertension, Canada, March 2007 to February 2009



† measured SBP higher than or equal to 140 mm Hg or DBP higher than or equal to 90 mm Hg, or current use of antihypertensive medication
‡ measured SBP lower than 140 mm Hg and DBP lower than 90 mm Hg
E interpret with caution (coefficient of variation 16.6% to 33.3%)
Note: Because of rounding, the sum of the estimates exceeds 100%.
Source: 2007-2009 Canadian Health Measures Survey

Table 4
Percentage with measured hypertension, by type, sex and age group, household population aged 20 to 79 years, Canada, March 2007 to February 2009

Sex and age group	Total	Isolated systolic hypertension (SBP higher than or equal to 140, DBP lower than 90 mm Hg)	Isolated diastolic hypertension (SBP lower than 140, DBP higher than or equal to 90 mm Hg)	Both systolic and diastolic hypertension (SBP higher than or equal to 140 and DBP higher than or equal to 90 mm Hg)	Any systolic hypertension (regardless of DBP)	Any diastolic hypertension DBP (regardless of SBP)
Total	**6.6**	**3.9**	**1.2**[E]	**1.5**[E]	**5.4**	**2.7**
Sex						
Male†	6.6	3.2	1.7[E]	1.7[E]	4.8	3.4
Female	6.7	4.7*	F	1.3[E]	6.0	2.0*
Age group						
20 to 39 years	F	F	F	F	F	F
40 to 59 years†	6.4	2.1[E]	F	2.2[E]	4.3[E]	4.2[E]
60 to 79 years	17.7*	14.3*	F	2.6[E]	16.9*	3.4

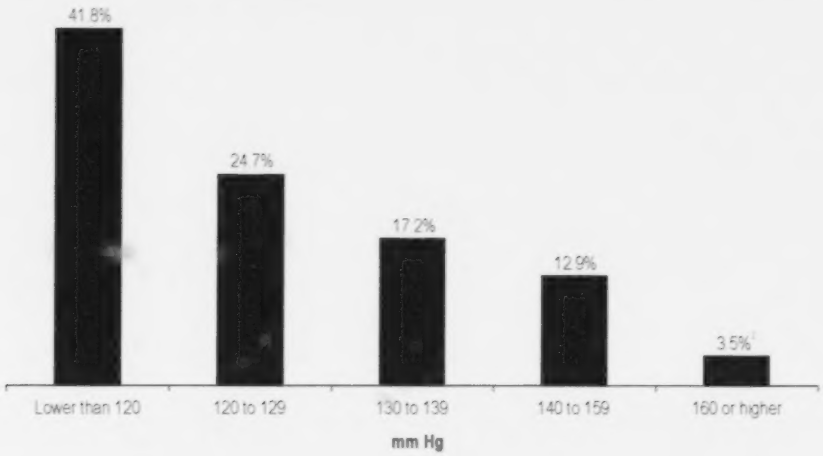
† reference category
* significantly different from estimate for reference category ($p<0.05$)
E interpret with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be reported (coefficient of variation greater than 33.3%)
Note: Total is sum of estimates for isolated elevated SBP, isolated elevated DBP and both elevated SBP and DBP.
Source: 2007-2009 Canadian Health Measures Survey

Canadian Heart Health Surveys (CHHS) (21% in 1985-1992 among people aged 18 to 74 years).[10] The average SBP of males aged 20 to 79 years (115.1 mm Hg) is considerably lower than that estimated from the CHHS for males (not including residents of Ontario) aged 18 to 74 years (126.0 mm Hg); the corresponding estimates for females are 111.1 and 118.7 mm Hg.[8] However, in view of the aging of the population, increases in obesity,[29] poor dietary habits[29] and diminishing fitness,[30] true declines of this magnitude are unlikely. The lower values in the CHMS data probably result from a combination of factors, the most important of which are differences in measurement methods between the CHHS and the CHMS.

The automated method of BP measurement that was used in the CHMS has been shown to yield BP measures 3/3 mm Hg lower than the manual method, based on readings at a single visit.[31,32] Other research suggests that the presence of an observer is associated with an even greater difference between manual and automated measures.[33] However, these studies were limited by a referral bias toward white coat hypertension, or the lack of standardized observer training or uniform measurement techniques; therefore, greater differences between manual and automated measures might be expected. BP measures for the CHHS took place during two visits (one of which was in the respondent's home), compared with only one for the CHMS, a factor that may have somewhat offset differences between the two surveys.[34] Further study of the impact of measurement mode on blood pressure values is underway in the United States, where both automated and manual measures were carried out in the 2007/2008 cycle of the National Health and Nutrition Examination Survey (NHANES).[35]

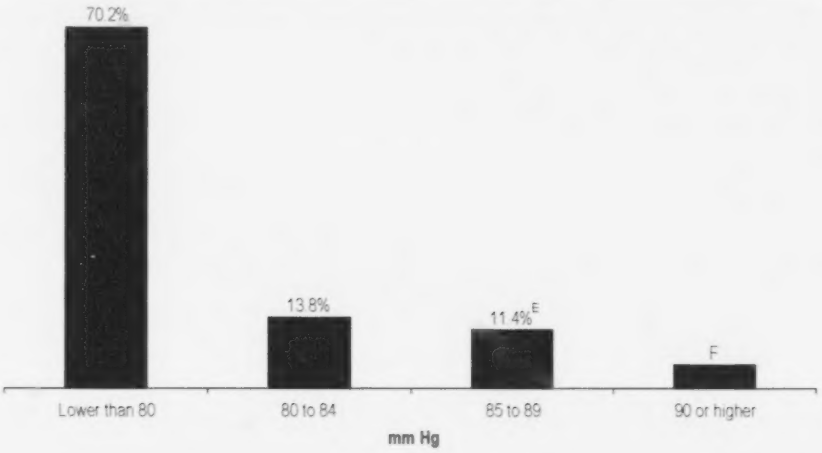
CHMS estimates of hypertension awareness and control are markedly higher than those from the earlier period; the percentages of people with hypertension who were aware of their condition increased from 57% to 83%; treated, from 34% to 80%; and controlled, from 13% to 66%.[10]

Figure 4
Percentage distribution of SBP (mm Hg), household population aged 20 to 79 years reporting current use of antihypertensive medication, Canada, March 2007 to February 2009



[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
Source: 2007-2009 Canadian Health Measures Survey

Figure 5
Percentage distribution of DBP (mm Hg), household population aged 20 to 79 years reporting current use of antihypertensive medication, Canada, March 2007 to February 2009



[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be reported (coefficient of variation greater than 33.3%)
Source: 2007-2009 Canadian Health Measures Survey

However, these comparisons may also be somewhat misleading. The use of automated measurement in the CHMS may partially account for lower values of blood pressure than were observed in the earlier survey, and thus, may also explain some of the apparently higher level of control.

The 66% level of hypertension control estimated from the CHMS is equivalent to that reported from the recent physical measures survey in Ontario for which automated BP measures were also employed.[12] As discussed above, various measurement factors hamper the comparability of estimates, so as would be expected, lower levels of control (defined as the percentage of hypertensives whose measured BP is less than 140/90 mm Hg) have been reported elsewhere: for example, 44% in the United States (2005-2006)[36] and 28% in England (2006).[37]

Although it is difficult to quantify the effect of differences in measurement methods on estimates of hypertension, awareness, treatment and control, it is reasonable to assume that some of the observed change over time is due to true improvement. Such progress would be consistent with large increases in diagnosis, treatment and drug prescriptions for hypertension that have occurred in Canada,[38-40] and the commensurate reductions in cardiovascular deaths and hospitalization.[39,41,42] Increases in hypertension treatment and diagnosis and subsequent reductions in cardiovascular complications may, in part, be attributed to the efforts of a variety of organizations and initiatives dedicated to raising public awareness and educating health care professionals in hypertension management.[11]

For this analysis, the definition of hypertension "treatment" was restricted to the use of medication, without consideration of other, non-pharmaceutical strategies such as dietary sodium restriction, physical activity or weight control. However, the CHMS definitions of treatment and control are the same as those used by NHANES,[36] so in this respect, the surveys are comparable.

As has been observed in other countries, awareness of hypertension was higher in females than in males.[37,43,44] Despite lower rates of awareness and treatment among males, the percentages of males and females with hypertension that was controlled by medication were nearly equal. Among those being

What is already known on this subject?

- High blood pressure (BP) is a major risk factor for heart and vascular disease and is an important cause of death around the world.
- The last nationwide surveys in Canada that included direct measures of BP took place over the period 1985 to 1992. The prevalence of hypertension (systolic BP higher than or equal to 140 or diastolic BP higher than or equal to 90 mm Hg, or self-report of recent medication use for high BP) in adults was estimated at 21%.
- According to a 2006 Ontario survey that involved direct measures of BP using an automated device, the prevalence of hypertension in adults was estimated at 19%.

What does this study add?

- Based on data from the 2007-2009 Canadian Health Measures Survey, including BP values and respondent self-report of medication use, hypertension prevalence in adults aged 20 to 79 years was estimated at 19%.
- Of people with hypertension, 83% were aware of their condition, 80% were being treated pharmaceutically, and 66% had BP below 140/90 mm Hg.
- Considerable improvements in hypertension awareness and control have been achieved in Canada over the past two decades.

treated, however, at older ages, females were less likely than males to have controlled hypertension; this finding is important and raises questions worthy of further study. Similar differences in treatment effectiveness for women have been observed in China, Spain and the United States[45]; the possible role of gender- or sex-related differences in genetic, environmental or clinical factors remains unclear. An analysis of data from the 1999-2004 NHANES revealed the same disparity, even after controlling for age, race/ethnicity and comorbidity.[46] Finally, a recently published study of over 18,000 patients with hypertension provides further evidence that although females are more often treated for hypertension, control is less successful than in males.[47]

The CHMS finding of a higher prevalence of systolic than diastolic hypertension is noteworthy in light of the greater importance of systolic hypertension as a cardiovascular risk factor in people older than 50 years.[48] The predominance of systolic hypertension may reflect the consequences of a tendency, at least until recently, for clinicians to treat it less aggressively than diastolic hypertension.[49-51] Indeed, before 1993, hypertension treatment guidelines issued by the Canadian Hypertension Society were based only on DBP levels; in that year, a SBP of 160 was added to the clinical definition of hypertension.[52] In 2001, treatment recommendations were updated to include the 140/90 mmHg cut-point for the first time, and clear diagnostic criteria for diagnosing hypertension based on SBP were set.[53,54]

The CHMS data indicated that a substantial percentage of adults had measured BP that placed them in the prehypertensive range. Although clinical guidelines do not recommend pharmacological antihypertensive therapy for people with prehypertension, strategies to modify factors including diet, weight, smoking, exercise and stress are recommended.[48,55] Prehypertension is associated with an increased risk of cardiovascular events[56] and is strongly predictive of hypertension.[27,48] About half of the health-related burden of elevated BP is estimated to occur at the level of SBP less than 145 mm Hg.[5]

Limitations

Data from the interview component of the CHMS were self-reported and not validated against external sources; the degree to which they are inaccurate is unknown. In particular, the reference period for medication use for BP was one month before the CHMS interview; inaccurate recall of the time when medication was used may have resulted in some misclassification of treatment status. As well, some respondents may have inaccurately reported the condition for which their medication was prescribed.

No information on dosage of antihypertensive medication being used or medication compliance was collected from respondents, nor were they asked about BP control measures other than pharmacotherapy. Therefore, the term "treated" was applied only to persons who reported medication use, and excluded those whose hypertension was being managed with non-pharmacologic therapy only. This may have resulted in a different percentage of hypertension control than would have been observed if the definition of treatment had been extended to non-pharmaceutical lifestyle interventions.

The overall response rate to the CHMS was 51%, meaning that in nearly half of households contacted, arrangements could not be made—for a variety of reasons—for a resident to participate. Although the survey weights were adjusted to ensure that the sample is representative of the target population according to socio-demographic characteristics, differences in health status (specifically, BP) were not accounted for. It is possible that the mean BP of those who participated in the survey differed from that of non-participants, which would compromise the external validity of the estimates. The 51% CHMS response rate compares favourably with that of the 2006 Ontario Survey on the Prevalence and Control of Hypertension (40%),[12] and is similar to that of the 1981 Canada Fitness Survey (49.5%).[30]

Conclusion

Based on highly accurate measures of BP in a representative sample of Canadian adults, this report provides a long-awaited update of the prevalence

and control of hypertension in Canada. The study suggests that hypertension awareness, treatment and control have increased in the past decade, following the establishment of an ambitious program aimed at clarifying hypertension treatment guidelines and reminding clinicians of the importance of hypertension control. However, the finding that hypertension is uncontrolled in 34% of Canadians with the condition is evidence of the challenge that remains.

The rich array of data collected by the CHMS offers the opportunity for more detailed analyses focusing on BP. Forthcoming studies will identify the characteristics of subpopulations in whom hypertension is untreated or suboptimally controlled.

This study provides benchmark estimates of blood pressure distribution and hypertension in the Canadian population, based on direct automated measures. As subsequent cycles of CHMS data become available, assessments of trends over time can be made with greater precision. In addition, follow-up studies based on CHMS records linked to hospital and mortality data will provide opportunities to more accurately quantify the risks of cardiovascular disease and stroke in relation to BP level. ■

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